Evaluation of Ambient Metals in the San Francisco, California Area

Presentation for the NDIA Conference

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Team Credits

- **Geologists –**
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- **Health Risk Assessor –**
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- **Chemical Engineering**
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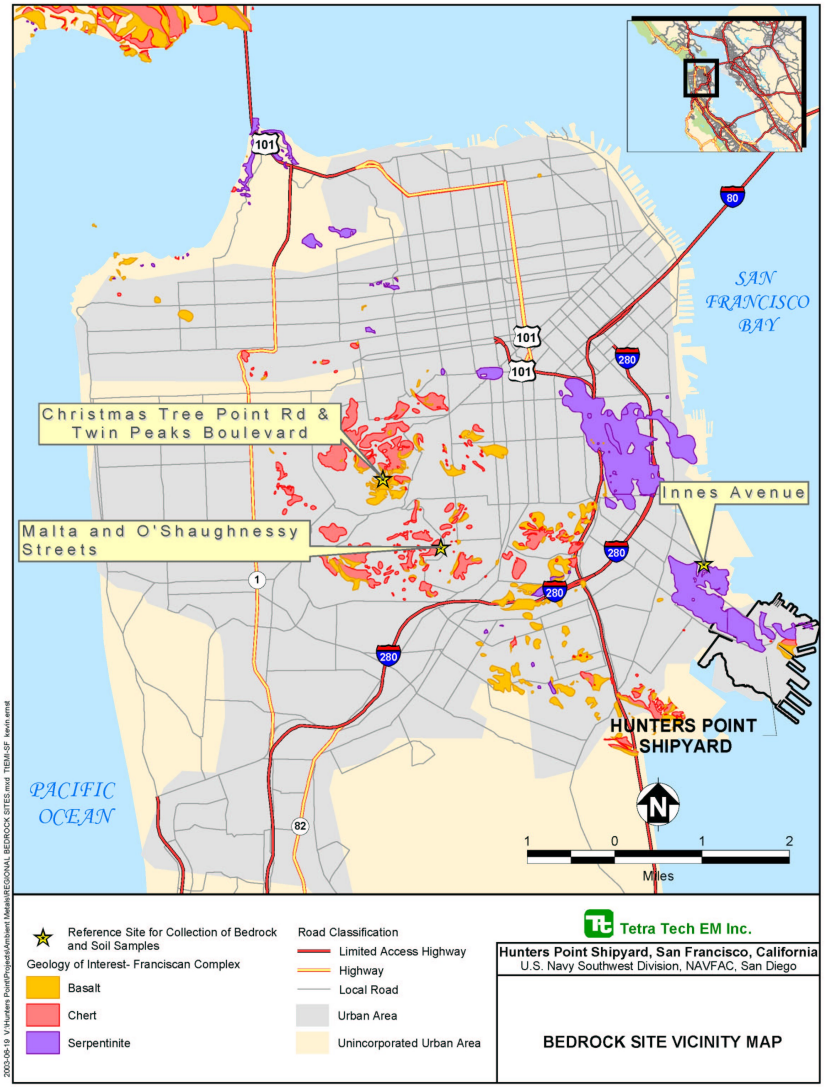
Purpose of Investigation

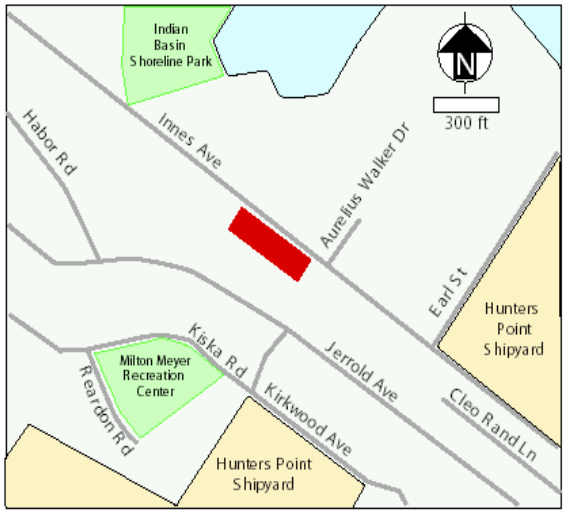
- **Assess naturally occurring metals in Franciscan Complex bedrock and bedrock-derived soils**
  - **Collect samples at 3 nonindustrial sites in San Francisco, CA**
  - **Sites have similar geological setting as Hunters Point Shipyard (serpentinite, chert, and basalt bedrock)**
- **Assess the concentration range of naturally occurring metals at San Francisco sites underlain by Franciscan Complex bedrock**
  - **Help communicate risk posed by naturally occurring metals**

Bedrock Sampling Locations

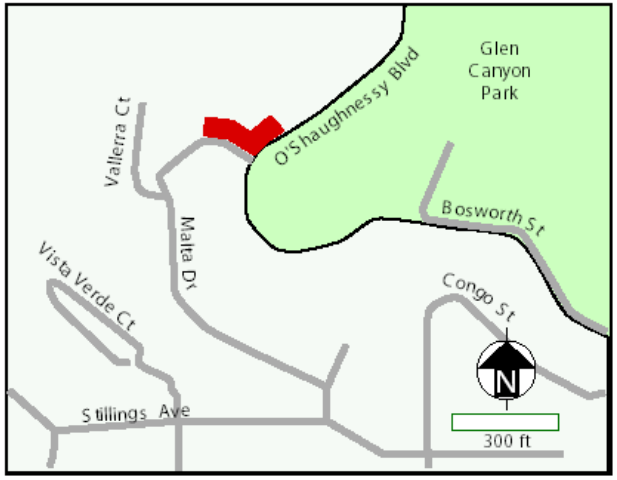


Bedrock Sampling Locations

Twin Peaks



Innes Avenue



Malta & O'Shaughnessey Streets

Geologic Setting

- Bedrock in San Francisco is a part of the Franciscan Complex, the predominant bedrock unit of the California Coast Ranges.
- Sampling locations from two Franciscan Complex subunits: (1) Hunters Point Shear Zone and (2) Marin Headlands Terrane.
  - Innes Avenue (serpentinite)
  - Twin Peaks Boulevard (chert)
  - Malta and O'Shaughnessy (chert)
- Geological setting at HPS is similar to the three study sites.
- Bedrock at HPS is part of the Hunters Point Shear Zone or Marin Headlands Terrane

Geology of Offsite Locations and HPS

- **Innes Avenue Site**
  - **Serpentinite bedrock is exposed in a roadcut.**
  - **Soil occurs above and at the base of the roadcut.**
  - **Soil is thin (generally less than 0.3 meters) and contains anthropogenic materials throughout.**
  - **Some pieces of chert found in the soil - likely derived from fill placed as road metal.**

Geology of Offsite Locations and HPS

- **Twin Peaks Boulevard Site**
  - **Located on the top of Twin Peaks in basalt and chert of the Marin Headlands Terrane.**
  - **Soil on the top of the northern hill appeared to be thin (0.5 meter)**

Geology of Offsite Locations and HPS

- **Malta and O'Shaughnessy Site**
  - **Located along a roadcut in chert and basalt of the Marin Headlands Terrane.**
  - **Undeveloped soil occurs only at the base of the slope and this is composed mainly of rock fragments that have fallen from roadcut.**

Data Collection

- Samples collected from rock outcrop areas in April, May, and June 2003.
- Two sample grids (one for rock and one for soil) were outlined at each site
- Each grid (30 feet or less on each side) was divided into 150 cells, and a random number generator was used to select 15 sampling points for each grid
  - A minimum of 30 samples (15 rock and 15 soil) were collected at each site
  - Sample locations documented using GPS
- A total of 100 samples were collected at the 3 offsite locations
  - Collected using a hand-auger to a maximum depth of 3 feet bgs
  - Analytical methods were EPA Method 6010 for metals; EPA Method 7471 for mercury; and EPA Method 9030B for soluble acid sulfides

Chemical and Geological Evaluation

- **Serpentinite Site (Innes Avenue):**
  - **Soil and rock samples indicated elevated concentrations of nickel.**
  - **Soils are higher in aluminum, arsenic, barium, calcium, lead, manganese, potassium, vanadium, and zinc than serpentinite bedrock.**
    - Chert found in the soil indicates that fill and soil are intermixed.
  - **Higher concentrations of arsenic, barium, lead, manganese, and zinc in the soil can be attributed to pieces of chert fill in the soil.**
  - **Higher concentrations of aluminum, calcium, and potassium are probably the result of pieces of basalt and/or sandstone fill, both of which are common fill materials in the Hunters Point area.**

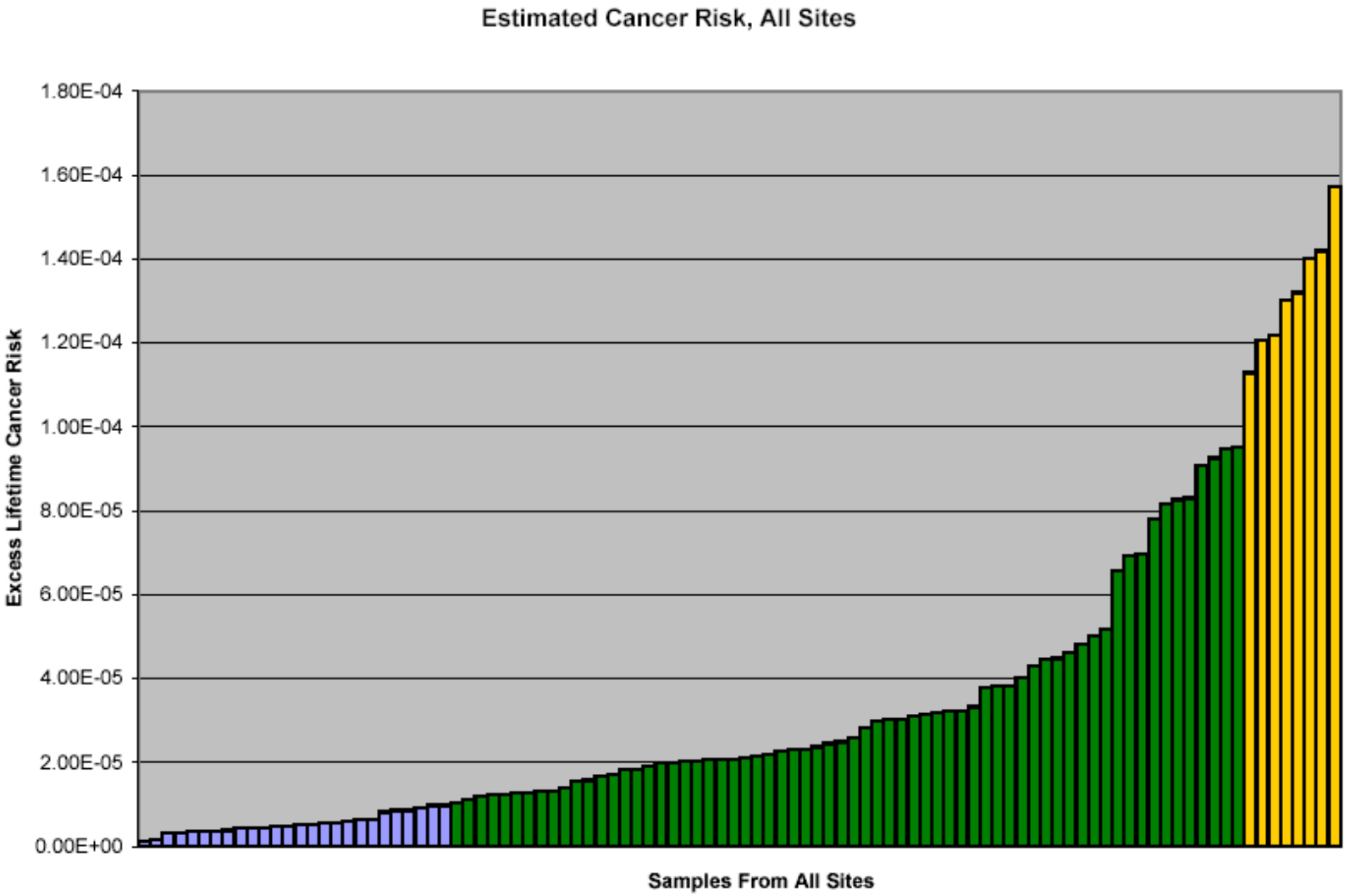
Chemical and Geological Evaluation

- **Chert Sites (Twin Peaks and Malta & O'Shaughnessey):**
  - **Both soil and rock samples have elevated concentrations of arsenic, iron, and manganese.**
  - **Soils tend to have higher calcium, potassium, and magnesium than rock.**
  - **Small fragments of basalt and sandstone in the soil may contribute to elevated concentrations of calcium, potassium and magnesium.**

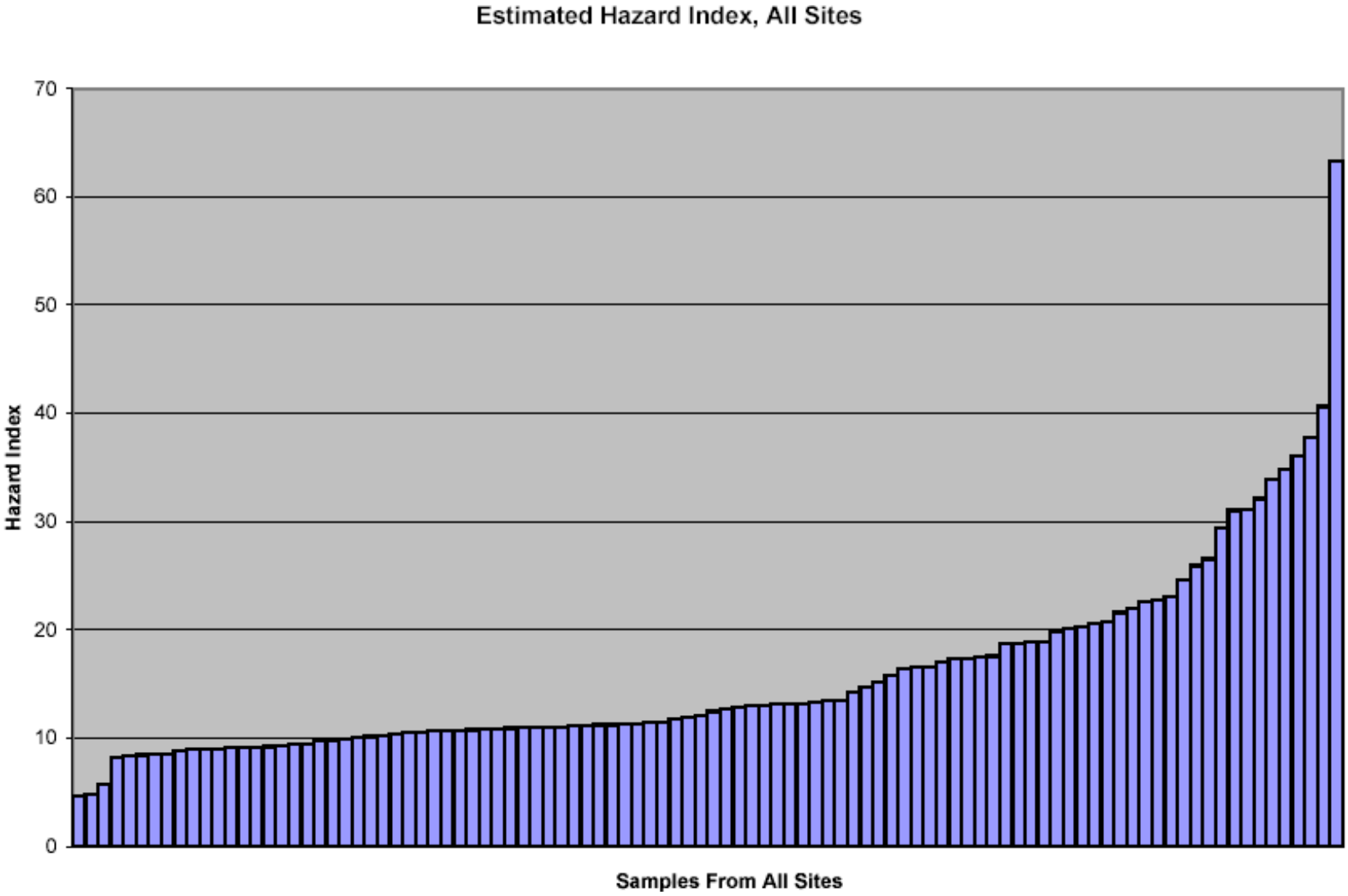
Human Health Risk Evaluation

- Excess lifetime cancer risk (ELCR) and hazard index (HI) were estimated based on residential exposure to metals
  - –HPS PRGs based on the EPA Region IX PRGs
    - **Adjusted to account for:**
    - **(1) the ingestion of homegrown produce, and**
    - **(2) Cal/EPA toxicity criteria were used when more conservative than EPA toxicity criteria.**
- HPS PRGs correspond to an ELCR of 1×10^{-6} or a noncancer hazard quotient (HQ) of 1, and assume the following exposure pathways:
  - –Ingestion of soil
  - –Dermal contact with soil
  - –Inhalation of volatiles and particulates from soil
  - –Ingestion of homegrown produce
- Data were compared to Hunters Point-Specific Preliminary Remediation Goals (HPS PRG) to estimate ELCR and HI from each sampling location.

Human Health Risk Evaluation Results



Human Health Risk Evaluation Results



Human Health Risk Evaluation Results

- ELCR and HI estimates generally higher at chert sites (Twin Peaks and Malta & O'Shaughnessey) than serpentinite site (Innes Avenue)
  - ELCR at Innes Avenue ranged from 1.2×10^{-6} to 1.6×10^{-5}
  - HI at Innes Avenue ranged from 4.8 to 15
  - ELCR at Twin Peaks and Malta & O'Shaughnessey sites ranged from 5.4×10^{-6} to 1.6×10^{-4};
  - HI at Twin Peaks and Malta & O'Shaughnessey sites ranged from 4.7 to 63.
- ELCR Statistics
  - ELCR $< 1 \times 10^{-5}$ in 26 percent of the samples
  - ELCR between 1×10^{-5} and 1×10^{-4} in 66 percent of the samples
  - ELCR $> 1 \times 10^{-4}$ in 8 percent of the samples.

Human Health Risk Evaluation Results

- ELCR at all sites is primarily attributable to arsenic.
- HI is primarily attributable to manganese and nickel.
- Higher arsenic, manganese, and nickel at chert sites result in higher ELCR and HI estimates than at chert sites.

Conclusions

- Metals that occur naturally in Franciscan Complex bedrock are present at levels greater than remediation goals at some Navy sites.
- Primary risk drivers are arsenic, manganese, and nickel.
- Naturally occurring metals in soil may also affect metals concentrations in groundwater.
- Identification of risk associated with nonindustrial sites has been an effective risk communication tool.